Wilderness Air Quality Value (WAQV) Class 2 Monitoring Plan
Rattlesnake and Welcome Creek Wilderness Areas, Lolo National Forest
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April 2, 2007

This Wilderness Air Quality Value (WAQV) Class 2 Plan was prepared to:

1. Summarize the wilderness characteristics of the Rattlesnake Wilderness (RW) and Welcome Creek Wilderness (WCW)
2. Explain the legal framework for air quality protection,
3. Identify wilderness air quality values, and
4. Provide a monitoring plan for Wilderness Air Quality Values (WAQV's).

The RW and WCW are Class 2 for the Clean Air Act Prevention of Significant Deterioration (PSD) regulations. Air quality protection authority (beyond ambient air quality standards and PSD increments) for this wilderness area therefore relies primarily upon the Wilderness Act. This plan is designed to specify appropriate monitoring to protect the Class 2 WAQV's and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3 http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

1) Location and Wilderness Characteristics

Rattlesnake Wilderness

The Rattlesnake Wilderness (RW) was designated as Wilderness on October 19, 1980 (Public Law 96-476). The southern boundary of the Rattlesnake National Recreation Area and Wilderness (RNRAW) is four miles north of Missoula, Montana. The National Recreation Area (NRA) receives heavy human use, primarily in the South Zone, within about three miles of the main Rattlesnake trailhead. Fewer people venture into the 32,976 acre Rattlesnake Wilderness which is in the more remote northern portion of the RNRAW. A primitive road leaves the main trailhead into the RNRAW along Rattlesnake Creek and up the NRA corridor to within about 3 miles of a scenic Wilderness cluster of high alpine lakes. Near the NRA entrance at about 3,600 feet, the elevation rises to 8,620 feet on McLeod Peak and a picturesque mountain setting. The RW is managed with the LAC (Limits of Acceptable Change) to maintain wilderness characteristics and values (USFS, 1992; USFS, 2005).

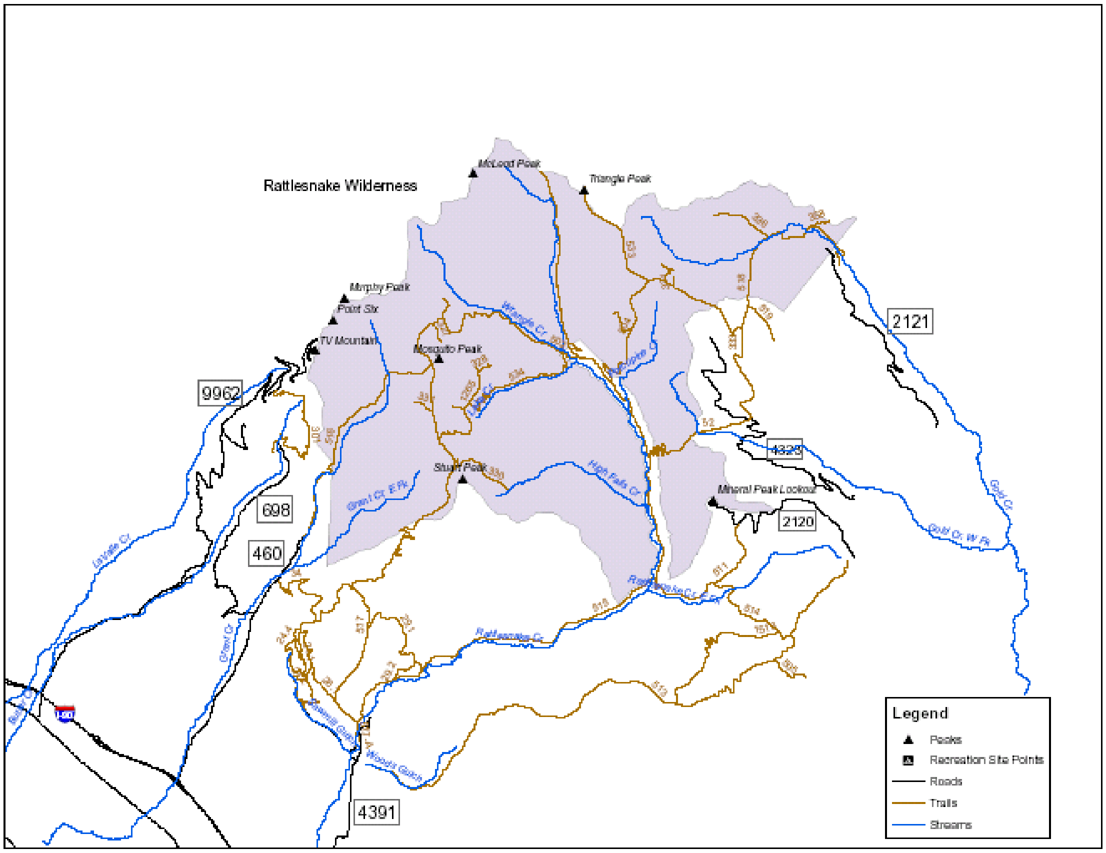
Deer, elk, coyotes, mountain goats, bighorn sheep, black bears, grizzly bears, moose, and mountain lions reside in the RW. Birds include eagles, hawks, ospreys, and wide variety of songbirds. Most of the wilderness lies in the Northern Continental Divide Grizzly Bear Recovery Area. Grizzly bears, while not common are regularly reportedly in the upper Wilderness. Bear proof food storage is required in all of the NRA and wilderness.

The northern boundary of the wilderness abuts the South Fork Jocko Tribal Primitive Area, upon whose sacred ground only tribal members are allowed.

Eight trailheads provide access to the RNRAW. Several of the small lakes and lake access trails are closed to livestock. Camping and campfires are restricted in the south zone of the NRA but are allowed in the Wilderness. Rattlesnake Creek is a municipal watershed for the City of

Missoula. Several of the lakes in the upper wilderness are dammed and maintained by Mountain Water Company, a local water company.

The Rattlesnake Wilderness has about 52 high mountain lakes.   Stream flow from the lakes then plunges down waterfalls to hanging valleys separated by sheer headwalls and carpets of sub-alpine fir, lodgepole pine, and spruce sloping down to open Douglas fir and ponderosa pine parklands.



Vicinity map of the Rattlesnake Wilderness Area

The Rattlesnake NRA provides many resources including wildlife habitat, recreation, watershed, water storage, historical, scientific, ecological, and educational.   From Stuart peak a knife edge ridge climbs still higher to the sentinel of the Rattlesnake-remote 8,620-foot McLeod Peak. The east side of the ridge is marked by cliffs, cirques, and rolling basins of intermittent subalpine forest where transplanted mountain goats are thriving in the security of protected wildlands.

The gentler western slopes lead down to the open bowl-like basin of upper Grant Creek. Although uncommon, occasional grizzly bears roam here.

The adjacent wildlands north of McLeod Peak and the rugged Rattlesnake Divide were once vision-quest sites for the Salish Indians. Today, the Flathead Indian Reservation protects this sacred land which is open to tribal members only.

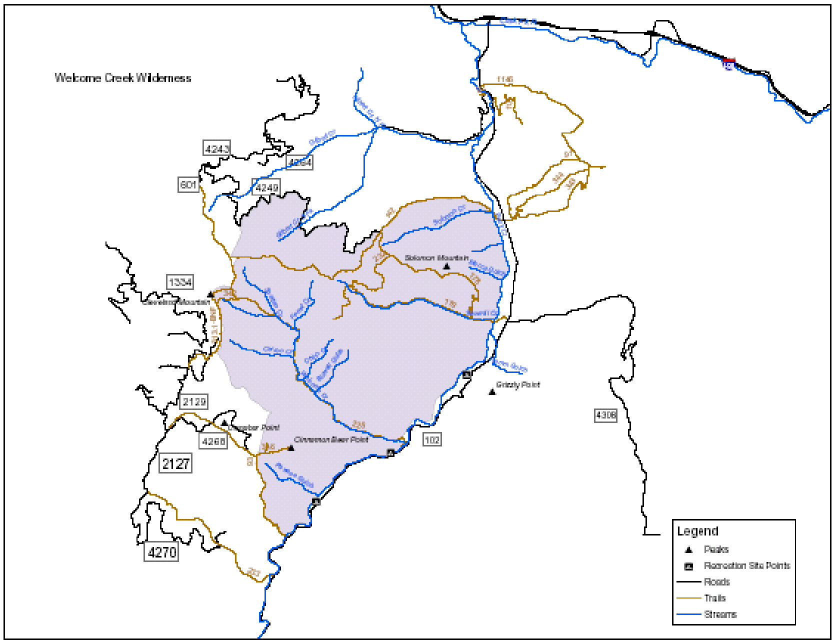
Day use is by far the dominant form of recreation, largely due to use by joggers and mountain bikers up both the main Rattlesnake Creek and Spring Gulch. Sight seeing, hunting, and fishing are some the traditional uses of the Rattlesnake Wilderness. The main Rattlesnake Creek is open to catch-and-release fishing above the mouth of Beeskove Creek. Some of the high lakes have been stocked in the past. When snow conditions permit, the main Rattlesnake and side drainages are used by cross-country and backcountry skiers.

Overview of Rattlesnake Wilderness crest and high lakes. (photo courtesy of summitpost.org)

Sanders Peak and Lake below. (photo courtesy of summitpost.org)

Welcome Creek Wilderness

The Welcome Creek Wilderness (WCW) is managed by the Lolo National Forest and lies in the Rock Creek drainage about 25 miles east of Missoula, Montana. This 28,135 area was designated as a Wilderness area on February 24, 1978 (PL95-237) and measures about nine miles by seven miles. The land rises steeply from Rock Creek and continues to the main Sapphire Range Divide and then drops abruptly to form breaks that are steep and rough.

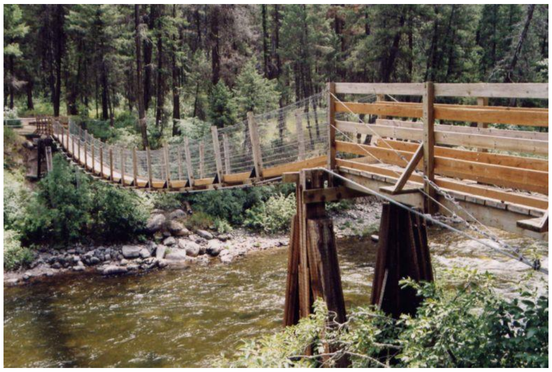


Elevations in the WCW range from 4,100 feet in Rock Creek to 7,723 feet on Welcome Peak. Most of the WCW is heavily timbered with pine, fir and larch (although the south-facing slopes have a few open but very steep grassy slopes) and is extremely rocky and rough. Welcome Creek flows south and east, providing a home to native trout. Elk hunters, bear hunters, and a few adventurous fishermen from Rock Creek are the most common visitors.

About 25 miles of steep trails provide foot and horse access, but overnight backpacking use is light. The main travel route is the Welcome Creek Trail, which crosses the area southeast to northwest for approximately seven miles. The Welcome Creek Wilderness has no lakes. The primary wildlife species include elk, deer, mountain lions, bobcats, pine martens, minks and weasels.

Welcome Creek has a colorful past. Gold was first discovered in Welcome Creek in 1888. During its short mining era Welcome Creek, one of the largest gold nuggets ever found in Montana was found, about 1.5 pounds.

The WCW has about thirty miles of trails, most of which are on steep ridges and in the narrow stream bottoms. The most popular route is across the Welcome Creek swinging bridge over Rock Creek. Cross-country skiing can be excellent in the high basins near or just below the Sapphire Divide.



Welcome Creek Wilderness access bridge across Rock Creek. (photo courtesy of bridgemeister.com).

2) Policy and Direction

The Wilderness Act of 1964 contains language directing the management of wilderness to "…secure for the American people…and future generations the benefits of an enduring resource of wilderness …unimpaired for future use and enjoyment~~.~~" (Wilderness Act, PL 88-577, Sec. 2a) It further states that Congress intended to manage these wildernesses so that "…the earth and it's community of life are untrammeled by man…" and a wilderness must"…retain it's primeval character and influence…" and it"…appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable~~…"~~" (Sec 2b). The direction provided in this act made it clear that Congress intended that the natural conditions in wilderness be preserved and that it be influenced primarily by the forces of nature rather than by human activity. The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act (CAA) of 1963, and amended in ~~1972~~1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value." Stringent requirements are therefore established for areas designated as "Class I" areas. Class I areas include Forest Service and Fish and Wildlife Service wilderness areas over 5,000 acres that were in existence before August 1977 and National Parks in excess of 6,000 acres as of August 5, 1977. Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Class II areas include all other areas of the country that are not Class I. To date, there are no class III areas. The RW and the WCW areas were designated Class II areas since they were established after 8/5/77 (RW in 1980 and WCW in 1978).

The purpose of the CAA is to protect and enhance air quality while ensuring the protection of public health and welfare. The act established National Ambient Air Quality Standards (NAAQS), which must be met by state and federal agencies, and private industry. The EPA has established NAAQS for specific pollutants emitted in significant quantities that may be a danger to public health and welfare. These pollutants are called criteria pollutants and include carbon monoxide, nitrogen oxide, ozone, ~~and~~ sulfur dioxide, lead, and particulate matter (PM_{10} and ~~PM2.5~~$PM_{2.5}$). States are given primary responsibility for air quality management. Section 110 of the Clean Air Act requires States to develop State Implementation Plans (SIP) that identify how NAAQS compliance will be achieved. The NAAQS are designed to protect human health and

public welfare. The CAA defines public welfare effects to include, but not be limited to, “effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being~~.~~” (CAA Title 1, Part A, S. 109 http://www.epa.gov/air/criteria.html). If a community or area does not meet or “attain” the standards, it becomes a non-attainment area and must demonstrate to the public and EPA how it will meet standards in the future. This demonstration is done through the ~~State Implementation Plan (~~SIP process~~)~~.

Criteria pollutants such as sulfur dioxide and nitrogen dioxide are of concern because of their potential to cause adverse effects on plant life, water quality, aquatic species, and visibility. However, sources of these pollutants are generally associated with urbanization and industrialization rather than with natural resource management activities or wildfire. Wildfire and natural resource management activities such as timber harvest, road construction, site preparation, mining, and fire use can generate ozone, carbon monoxide, and particulate matter. While ozone is a by product of fire, potential ozone exposures are infrequent (Sandberg and Dost 1990). The EPA is recommending a secondary ozone standard which will protect vegetation and animals http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_cr_sp.html. Carbon monoxide is rapidly diluted at short distances from a burning area, as fires are generally spatially and temporally dispersed, and pose little or no risk to public health (Sandberg and Dost 1990).

The pollutant of most concern to public health and visibility in the Rattlesnake Wilderness and the Welcome Creek Wilderness is particulate matter. Even though particulate matter has no serious effects on ecosystems (fire and smoke are natural processes) it does affect human health and visibility. Because of its smaller size, $PM_{2.5}$ poses greater respiratory health system risks than $PM_{10.}$

The $PM_{2.5}$ standard requires concentrations of $PM_{2.5}$ not to exceed a 24-hr average of 35 ug/m^3 (micrograms per cubic meter). This standard was changed from the previous 65 ug/m3 by the EPA on 12~~9~~/~~2~~17/06 http://www.epa.gov/particles/fs20061006.html. Average annual arithmetic $PM_{2.5}$ concentrations are not to exceed 15 ug/m^3. Air quality State Implementation plan (SIP) for particulates is promulgated through the Montana Clean Air Act and implementing regulations. The regulations provide specific guidance on maintenance of air quality, including restrictions on open burning (ARM 16.8.1300). The act created the Montana Air Quality Bureau (now the DEQ) and the regulatory authority to implement and enforce the codified regulations.

3) Pollution Sources and Air Quality Conditions

The RW and WCW air quality areas are good with limited upwind large stationary local emission sources and periodic robust wind dispersion. Existing sources of emissions in the wilderness areas include very limited dust from trails during dry conditions and smoke emissions from wildfires, wildland fire use, and prescribed burns. Adjacent area emissions include occasional construction equipment, vehicles, road dust, residential wood burning, wood fires, and smoke from logging slash disposal, prescribed burns, and wildfires. The RW receives vehicle, residential, construction from the Missoula area. The WCW has very limited local sources. Down valley airflow in the RW and WCW drainages is frequently robust during nighttime and early morning hours. The entire RW and WCW areas area considered to be in attainment by the Montana DEQ http://www.deq.mt.gov/AirQuality/Planning/AirNonattainment.asp

The main source of air pollutants to the RS and to a lesser degree the WCW is the city of Missoula and surrounding area. A history of Missoula air quality issues and trends is available at Missoula County, 2006 http://www.co.missoula.mt.us/EnvHealth/AirQ/aqindex.html. Missoula is currently in non-attainment of National Ambient air quality standards for PM_{10} and carbon monoxide http://www.deq.mt.gov/AirQuality/Planning/AirNonattainment.asp The major source of emissions in the Missoula valley includes vehicle exhaust, wood burning smoke, and road dust, and industrial emissions. The main permitted industrial sources in the Missoula valley include Stone Container for nitrogen dioxides (NOx) and Louisiana Pacific for PM_{10}. The EPA AIRS data base http://www.epa.gov/air/data/netemis.html lists 11 primary station sources of emissions within a 20 mile radius of the RW or WCW. The AIRS database includes 1999 emission levels in the Missoula and Seeley Lake areas which combine for about 2900 tons/year of NOx, 370 tons/year of PM_{10}, and 176 tons/year of SO_2.

Missoula and Rattlesnake and Welcome Creek area stationary emission sources

Pollutant Emissions tons/year										
CO	**NH3**	**NOx**	**PM10**	**PM2.5**	**SO2**	**VOC**	**CO**	**Facility Name**	**Location**	**Industry Type (SIC)**
3,804	0.40	2,253	697	564	149	871	91.25	Stone Container	Missoula	paperboard Mills
265		186	141	131	9.94	92.8	6.37	Stimson Lumber -	East, Bonner	sawmills & planing mills
54.0		435	348	258	6.49	15.4	1.30	Louisiana-Pacific	Missoula	wood products
23.6		56.3	141	108	0.87	8.26	0.57	Pyramid Mtn Lumber	Seeley Lake	sawmills & planing mills
11.1		4.42				59.9	0.27	Conoco, Inc. Bulk Terminal	Missoula	petroleum bulk stations & terminals
5.71		0.48	3.42	2.07	3.26	2.65	0.14	Jensen Paving	Missoula	sand And gravel
3.04		4.19	1.45	0.89	2.24	1.52	0.07	Allied Waste Systems	Missoula,	refuse systems
1.55		1.46	4.93	3.66	2.97	1.14	0.04	JTL Group Westview	Missoula	highway construction
0.41		1.15	16.2	6.03	0.78	0.31	0.01	Jensen Paving	Missoula	paving mixtures & blocks
			0.69	0.06				Missoula Ready Mix	Missoula,	ready-mixed concrete
			16.7	10.3				JTL Group Target Range	Missoula,	paving mixtures & blocks
4,169	0.40	2,941	1,371	1,084	176	1,053	l	total		

The Missoula urban area, located in the Bitterroot River and Clark Fork River valley, contains over 75,000 people. Because of the mountain valley topography, winter temperature inversions that trap pollution are common. The 1967 Montana Clean Air Act authorized local air pollution control programs. By 1969, the Missoula City-County Health Department had developed a local air pollution control program and assumed responsibility for most sources of air pollution in Missoula County. The Missoula urban area has a history of exceeding the Montana and National Ambient Air Quality particulate standards and the 8-hour carbon monoxide standard. The first recorded exceedances were 1969 for particulate matter (TSP) and 1977 for carbon monoxide. Because the National Ambient Air Quality Standards were exceeded, Missoula had to write State Implementation Plans detailing how Missoula would attain and then maintain pollution levels below the federal standards. By 1974, strict enforcement of emission standards had reduced industrial emissions in the valley by over 90%. Wood burning emissions in the Missoula valley peaked around 1983 and have declined with reduced burning and more efficient stove.

Missoula Residential Wood Burning Trends

Survey Year	1977	1980	1983	1986	1992	1996
Number of Households	21,305	21,970	22,875	23,325	26,930	27,205
Number of Burners	8,032	11,666	11,483	10,193	6,732	5,332
% RWB	37.7	53.1	50.2	43.7	25.0	19.6
Tons Burned	25,912	54,120	40,296	33,174	22,297	15,151
Tons CO Emitted	2,462	5,141	6,362	6,316	3,595	1,569
Tons PM_{10} Emitted	648	1,218	1,316	1,079	608	206

Source Missoula County health Department at http://www.co.missoula.mt.us/EnvHealth/AirQ/aqindex.html

Missoula exceeded the annual average PM_{10} standard in 1986 and exceeded the 24-hour PM_{10} standard several times between 1987 and 1989. Because of these exceedances, Missoula was designated a non-attainment area for PM_{10} and Montana was required to submit a State Implementation Plan (SIP) to the Federal Environmental Protection Agency by 1990 that included monitoring, emission inventories, chemical analysis of particulate to identify sources, and regulations adequate to meet the PM_{10} standard in Missoula within three years. This plan was written by the Missoula City-County Health Department. To reduce PM_{10} emissions in the valley, both the city and the county adopted regulations on residential wood stoves, outdoor burning, industry, fugitive emissions, street sanding and street maintenance with PM_{10} reductions consistent over the last 10 years. Wood smoke is a major source of air pollution in the Missoula valley. As a result, the Air Pollution Control Board adopted even more stringent rules in 1994 to help maintain and improve air quality in the Missoula Valley. In 1994 it became illegal to install woodstoves in the Air Stagnation Zone. Now, only pellet stoves and gas appliances may be installed inside the Air Stagnation Zone. In addition, all solid fuel burning devices inside the Air Stagnation Zone that emit more than 5.5 grams particulate per hour must be removed upon the sale of a property.

During the summer, outdoor burning, forest fires, road dust, and construction fugitive emissions often impact the Missoula airshed during the summer quarters.

Regional wildfire smoke has accumulated within the Missoula area, as well as much of western Montana during periods of extensive wildfire activity in 1988, 1994, 2000, 2003, and 2006. The prime source of wildfire emissions is from central and northern Idaho, and western Montana.

Missoula County monitoring (chemical mass balance) has shown that in recent years wood burning emissions have decreased while vehicle related emissions, mostly road dust, have increased.

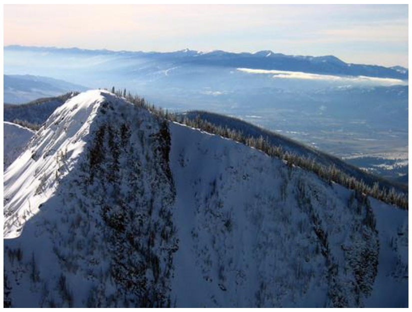
EPA designated the city of Missoula a nonattainment area for carbon monoxide in 1978 based on less than one year of monitoring data collected by Missoula County and DHES (Montana DEQ, 2006) http://www.deq.state.mt.us/AirMonitoring/citguide/understanding.asp

The 1977 data showed 55 measurements that exceeded the eight-hour national standard by as much as 50 percent at monitoring stations downtown and at the intersection of Brooks Street (U.S. Highway 12), Russell Street, and South Avenue.

Because of its CO nonattainment status, Missoula was required by the 1990 Clean Air Act Amendments to develop an oxygenated fuels program. Oxygenated fuels have either alcohol-based or ether-based fuel additives that increase the oxygen content of gasoline, allowing for a cleaner burn. Missoula identified an Oxygenated Fuel Control Area where gas stations were required to sell "oxyfuels" during the months of November, December, January, and February, because these are the months Missoula experiences the worst carbon monoxide impacts. Missoula, the surrounding communities of Lolo to the south and Bonner/Milltown to the east, and the intersection of U.S. Highways 93/200 with Interstate 90 to the northwest were included in the Oxygenated Fuel Control Area. Since 1993, the first full year that oxyfuels were available, carbon monoxide ambient impacts have declined below the standard. This decline has been and still is a direct result of Missoula's oxyfuels program. Missoula has been compliant with all state and federal air quality standards since 1993 and is considering taking the first step toward having its carbon monoxide nonattainment status lifted. To do so, the citizens of Missoula will have to adopt a maintenance plan with DEQ assistance that would keep them in compliance with the carbon monoxide standard.

The nearest Class I area to the RW or WCW is the northeast part of the Selway Bitterroot Wilderness which is about 13 miles west of the WCW and 23 miles SW of the RW. The Flathead Indian Reservation is a non-Federal Class 1 area which abuts the RW on the north (South Fork Jocko Tribal Primitive Area).

Although Missoula winter inversions can be trap air pollution for several days, the inversions ceilings are generally too low to substantially impact the RW or WCW. The inversions tend to clear out vertically with a predominant NW wind which disperses emissions south and east of the I-90 corridor. Missoula Health Department (Schmidt, personal correspondence, 2006) observes that the inversion “clearouts” tend to go south of the RS and are considerably dispersed by the WCW.

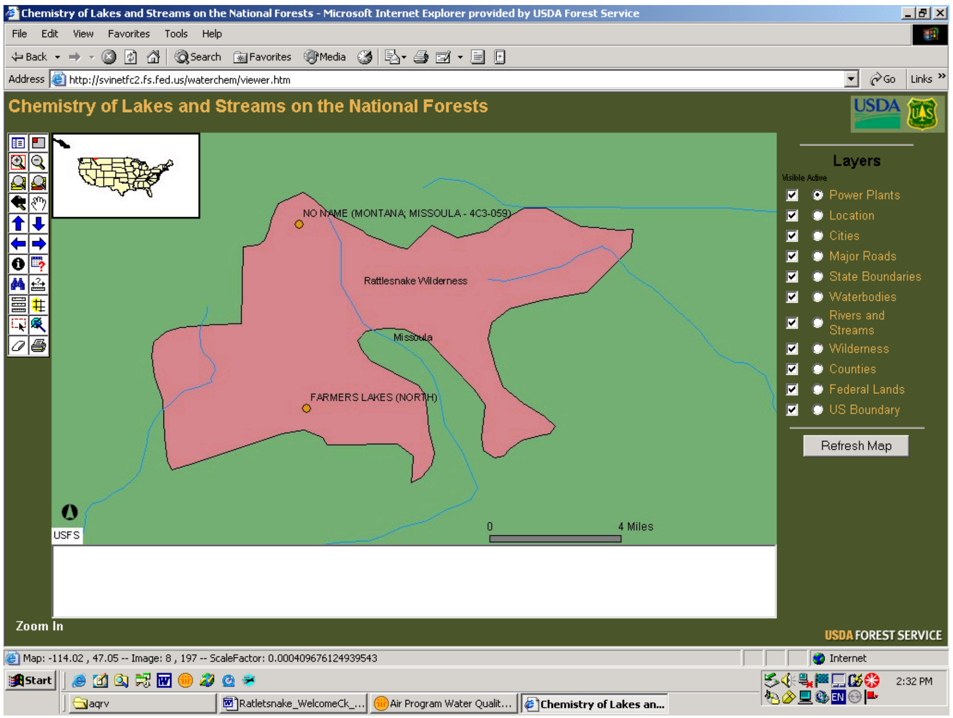


Rattlesnake Wilderness in foreground with Missoula inversion in valley below (photo courtesy of summitpost.org).

Lake Chemistry

This chemical record can indicate changes in a lake's composition, which in sensitive lakes is very diagnostic of atmospheric chemistry. Imbalance of lake chemistry can affect microorganisms, and invertebrates, ultimately affecting the health and productivity of fish. The lake chemistry in the RW was monitored by the EPA (1985) Western Lake Survey at 2 lakes (Landers, et.al, 1987) with locations shown on the map below from the USFS Air lake data website at http://svinetfc2.fs.fed.us/waterchem/viewer.htm

				ANC	HCO3	Ca	Mg	Na	K
Lake	Location	Lake ID	pH	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l
Farmers	15N 18W S5	4C3-031	7.1	67.2	67.3	40.1	24.6	9.7	3.6
No Name		4C3-059	7.79	292	263.4	170.4	137	9.7	2.1
			NH4	SO4	Cl	NO3	F	Cond.	
Lake	Location	Lake ID	ueq/l	ueq/l	ueq/l	ueq/l	ueq/l	uS/cm	
Farmers	15N 18W S5	4C3-031	0	8.2	2.2	0.1	0.5	8.4	
No Name		4C3-059	0	10.5	7.4	4.3	0.4	30.1	

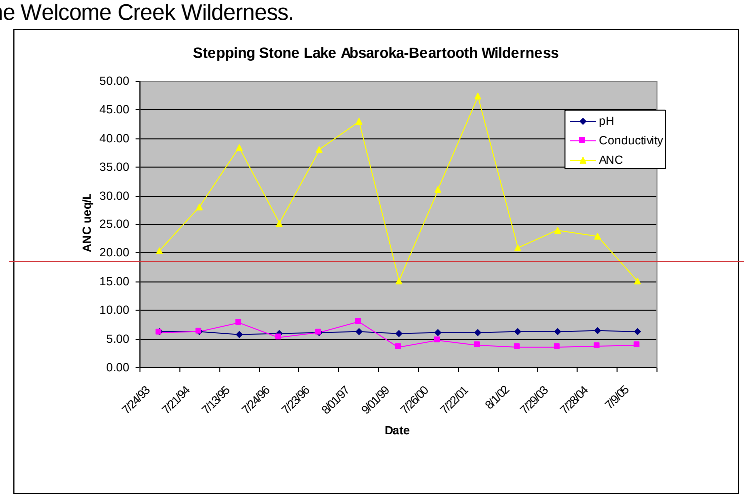


The Montana DFWP has sampled 15 lakes the RW in the 1970's (data from NRIS at Montana State Library) and 4 lakes in 2006 (data courtesy of Ladd Knotek, DFWP) as part of fishery surveys. Water chemistry data from the DFWP lake surveys include:

Lake	Location	Lake ID	pH	ANC ueq/l	HCO3 ueq/l	F ueq/l	Cond. uS/cm	TDS ppm
Big	15N 18W S19	DFWP 1970's			160			
Carter	15N 18W S30	DFWP 1970's			140			
Farmers1	14N 18W S3	DFWP 1970's			160			
Farmers2	14N 18W S3	DFWP 1970's			180			
Little	15N 18W S19	DFWP 1970's			240			
Rattsnk2	15N 18W S13	DFWP 1970's			400			
Rattsnk14	15N 19W S12	DFWP 1970's			160			
Rattsnk15	15N 18W S13	DFWP 1970's			300			
Rattsnk16	15N 18W S7	DFWP			180			

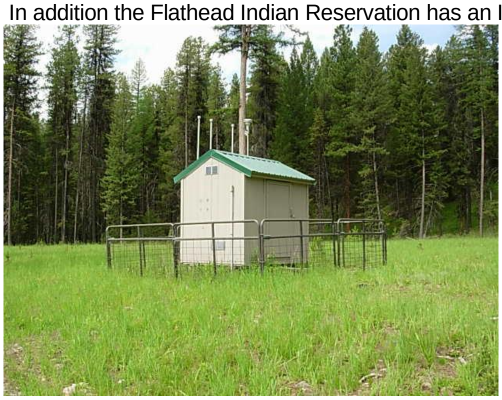
		1970's						
Rattsnk17	15N 18W S13	DFWP 1970's			500			
Rattsnk20	15N 18W S14	DFWP 1970's			140			
Rattsnk22	16N 18W S31	DFWP 1970's			300			
Sheridan	15N 18W S20	DFWP 1970's			200			
Sanders	15N 19W S13	DFWP 1970's			140			
Twin	15N 18W S31	DFWP 1970's			100			
Boulder	15N 18W S11	DFWP 8/2006	8.6-8.7				7	10
Bull	15N 18W S20	DFWP 8/2006	7.92-7.94				49-50	25
Gold Creek	15N 18W S2,3	DFWP 8/2006	9.2-9.3				21-21	10
Fly	15N 18W S1	DFWP 8/2006	9.3-9.5				130-131	60-66

The 52 RW lakes are located in the Precambrian Missoula Group (pCm) which is a complex sedimentary and metamorphic mosaic of various parent material types including argillite, quartzite, limestone, shale, and sandstone. A key indicator of buffering capacity and therefore pH and chemical/biological stability in a lake is acid neutralizing capacity (ANC), which is similar to bicarbonate alkalinity in most lake systems (including the RW) and is the sum of the base cations minus acid anions. Lakes are generally considered sensitive to atmospheric induced acid deposition change if ANC is less than 50 ueq/L and highly sensitive if ANC is less than 25 ueq/L. All of the RW lakes sampled had ANC and alkalinities more than 50 ueq/L. Average RW ANC and alkalinity is 213 ueq/L which indicates generally ample buffering to acid deposition induced acidification. Additional lake surveys by DFWP in the RW are planned in future years. No lakes occur in the Welcome Creek Wilderness.



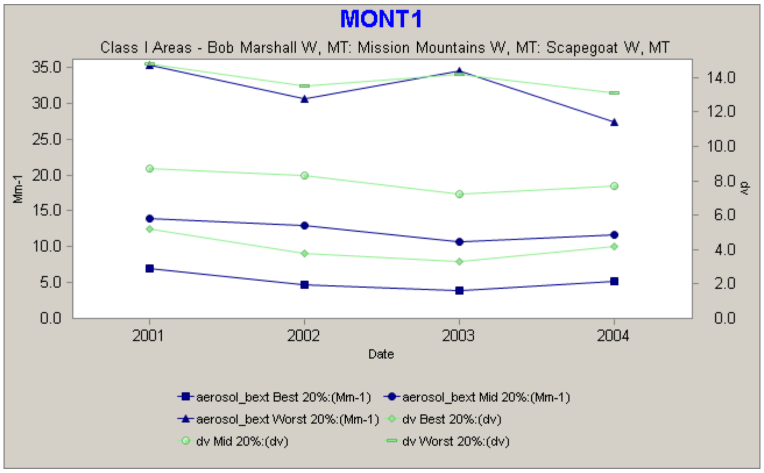
Visibility

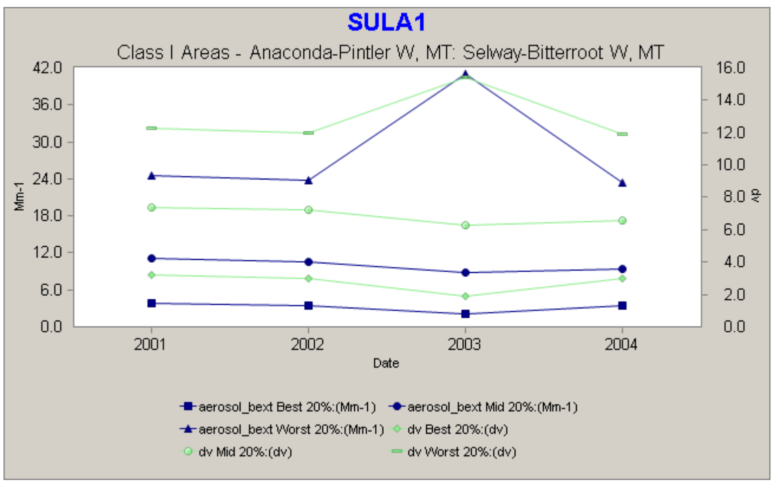
Visibility in both the RW and WCW is good due to absence of large stationary sources, generally dry air, and adequate wind dispersion. No visibility monitoring stations are located in or immediately adjacent to either the RW or WCW. ~~The~~ However, the Interagency Monitoring of Protected Visual Environments (IMPROVE) program (~~, however,~~ http://vista.cira.colostate.edu/improve/) has 2 IMPROVE sites in the vicinity of the RW and WCW. These include the Monture Guard Station IMPROVE site (29 miles east of the RW and 43 miles north of the WCW) and at Sula Peak Lookout IMPROVE site (70 miles south of the RSW and 55 miles south of the WCW). The Monture GS IMPROVE site (MONT1) has been in operation since 2000. In addition the Flathead Indian Reservation has an IMPROVE site (FLAT1).



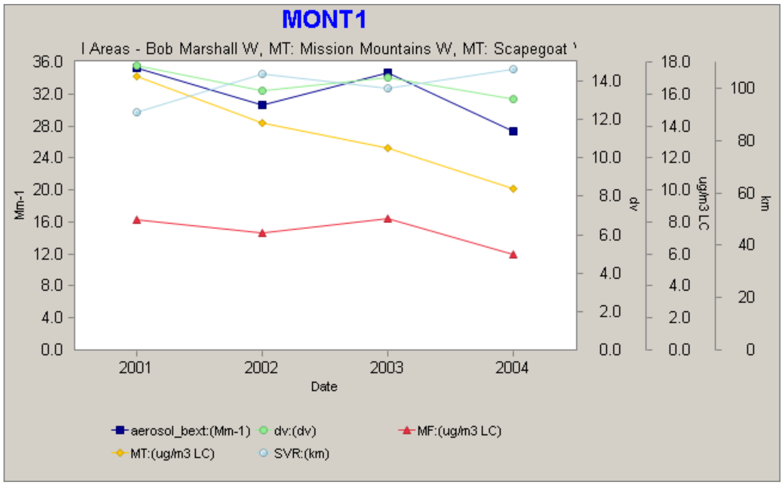
Monture Guard Station IMPROVE site, Lolo National Forest. This site houses 4 modules which pump air in 2@24 hour periods. Filters are changed each Tuesday then sampled for a wide variety of chemical air quality constituents.

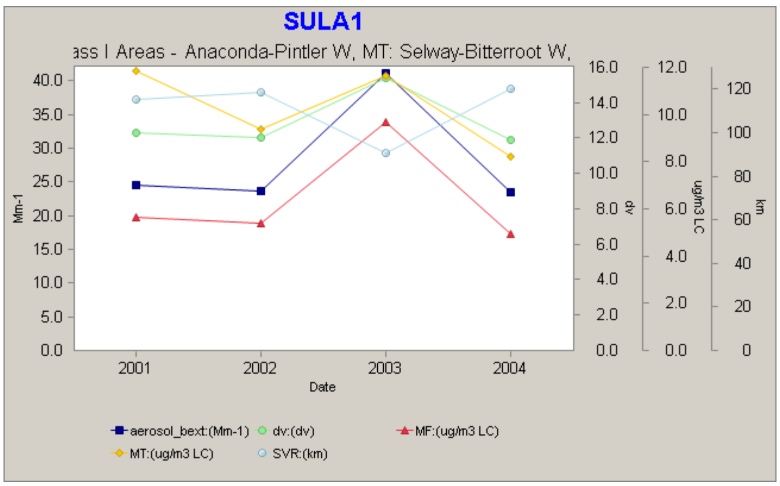
The Sula site (SULA1) has been operated since 1994. Trend data is available at http://vista.cira.colostate.edu/dev/web/AnnualSummaryDev/trends.aspx which shows visibility trends since the stations were installed. The graphs below show trends in light extinction and deciviews which are indices of visibility. Air quality State Implementation plan (SIP) for particulates is promulgated through the Montana Clean Air Act and implementing regulations. The deciview unit is a haze index which is a measure of visibility derived from calculated light extinction measurements so that uniform changes in the haze index correspond to uniform incremental changes in visual perception across the entire range of conditions from pristine to highly impaired. The haze index [in units of deciviews (dv)] is calculated directly from the total light extinction [bext expressed in inverse megameters (Mm-1)] as follows: HI = 10 in (b_{ext}/10). The trends for the Monture IMPROVE site show generally stable visibility with the lowest visibility (highest dv) occurring during 2003 which was a robust wildfire year on the Lolo NF around Missoula. The Sula IMPROVE site also had the highest deciviews during 2003.





The IMPROVE data was also converted for SVR (standard visual range in kilometers) and deciviews which shows the inverse correlation between SVR and deciviews. For the Monture and Sula Peak IMPROVE sites visibility is closely coorelated to wildfire activity. ~~which is the same for the North Absaroka Wilderness which had lower SVR due to the 2003 wildfire season.~~





Since the MONT1 and SULA 1 IMPROVE sites are proximate to the RW and WCW with only very minor emission sources between these sites and the wilderness areas. The IMPROVE sites are therefore reasonable~~y~~ approximations of visibility conditions in the RW and WCW.

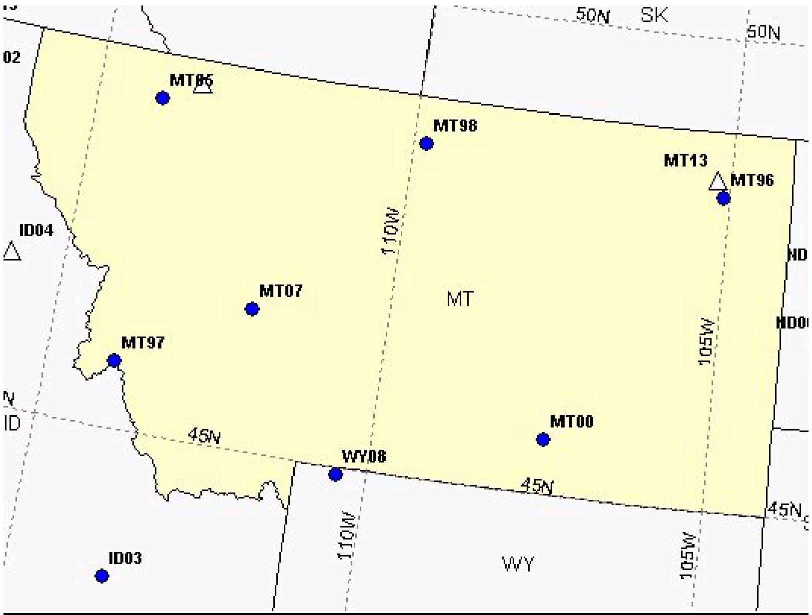
Snow Chemistry

The United States Geological Survey (USGS) Water Resource Division in Colorado, in cooperation with the USFS, NPS, and multiple other agencies and interest groups has been monitoring 52 seasonal (late winter), depth integrated, bulk snowpack sites along the Continental Divide from New Mexico through Montana since 1993, (Ingersoll et. al., 2002a)

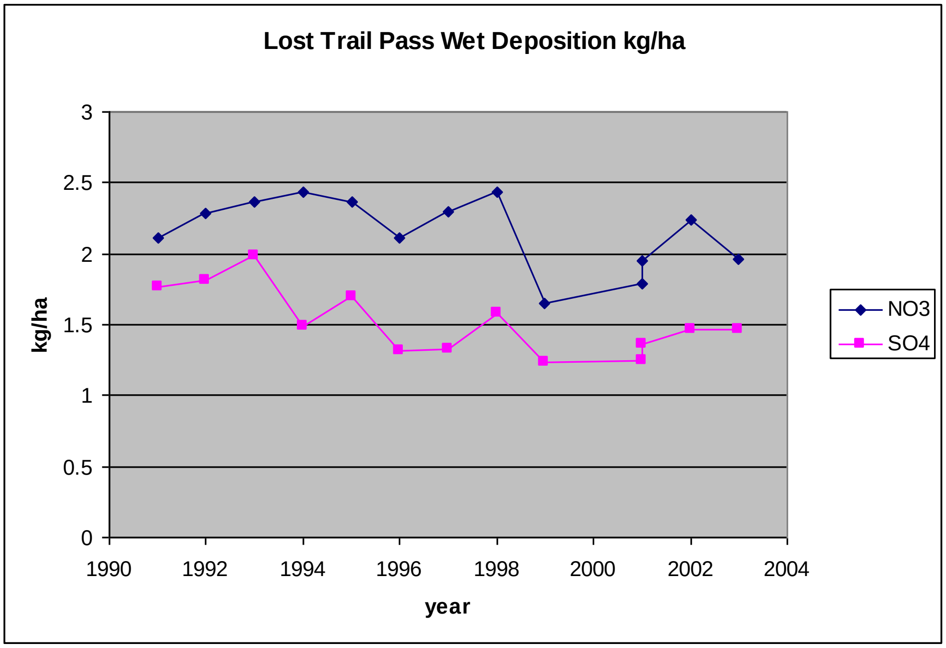
http://pubs.usgs.gov/of/2001/ofr01-466/ . Three of these sites are near the RW and WCW including Snow Bowl (1 mile from RW and 33 miles from WCW), Granite Pass (39 miles from RW and 44 miles from WCW), and Red Mountain Pass (112 mile from RW and 84 miles from WCW). Bulk late winter snowpack samples provide a very useful diagnosis of chemical deposition (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) from all transport sources (short and long range) through the late fall and winter period. The samples are collected in a depth integrated fashion prior to spring snowmelt rinsing of the snowpack which quickly flushes the soluble chemical constituents from the snowpacks (~~-~~Ingersoll et. al., (2001, 2002, 2003, 2004, and 2005). The snowpack monitoring has documented generally decreasing levels of snowpack contaminants from south (New Mexico and Colorado) north through Montana. The Snow Bowl, Granite Pass, and Red Mountain sites have generally low (dilute) amounts of contaminants.

NADP Sites

The RW and WCW are triangulated by the 3 NADP (National Atmospheric Deposition Program) sites in Western Wyoming including the MT05 site at Glacier National Park (operated by the NPS), MT07 site at Clancy Montana (operated by the USGS), and the Lost Trail Pass MT97 site (operated by the Bitterroot NF). The NADP Program was initiated in 1978 to monitor geographical and temporal trends in the chemical composition of rain and snow (wet deposition) with the primary purpose of acid rain benchmark monitoring. The program was prompted by scientific evidence and public concern in the 1970's that acid rain could be damaging aquatic ecosystems throughout the United States. The program grew steadily though the early 1980's and has stabilized at about 200 sites. The NADP network is used by a wide variety of government administrators and university scientists in monitoring the amounts of atmospheric deposition and effects on agriculture, forests, rangelands, freshwater streams, lakes, and cultural resources. Atmospheric deposition is commonly referred as "acid rain" but can occur as acid snow, fog, or dry deposition. The NADP data from all sites is readily retrievable at the NADP web site at http://nadp.sws.uiuc.edu.

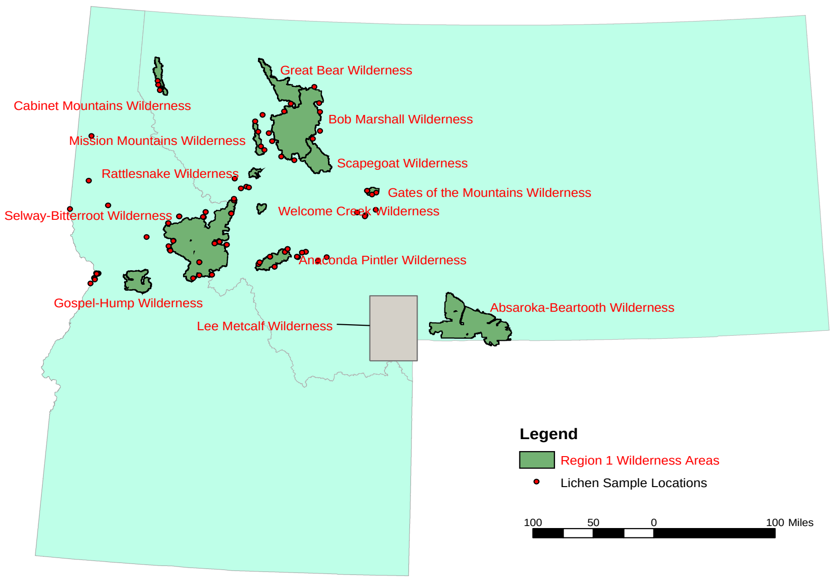


The Lost Trail Pass (MT97 site) is the closest and most closely related site to the RW and WCW but is largely not influence by the Missoula area urban emissions. The Lost Trail Pass NSDP site is monitored by the Sula RD of the Bitterroot NF which requires access to the site each Tuesday, yearlong. Sample bucket are changed then shipped to the Central Analytical Lab in Illinois for a wide varied of chemical constituent analysis.



An important parameter in trend analysis and acid deposition ecological significance is total wet deposition of sulfate and nitrate in kilograms/hectare (kg/ha). Annual NO_3 and SO_4 deposition per year for the Lost Trail Pass site is shown above (Story, 2005). Wet deposition is a function of total precipitation times concentration and is highly influenced by wet and drought years. In general, sulfate deposition slightly decreased through 2000 with a slight increase from 2000 to 2004. Annual nitrate deposition plots similarly. The slight increase in sulfate and nitrate deposition from 2000 through 2004 may be due primarily to increased precipitation after 2000. The overall lack of increase in nitrate deposition at MT97 is not consistent with overall trends for mobile source (vehicle) emissions in the Western US, which are increasing for NOx emissions (Peterson and Sullivan, 1998). In general NOx emissions are increasing in the Western US due to mobile source as the population grows as well as increasing small industrial facilities (Lynch, 1995, 1996). The slight decrease in overall sulfate deposition is consistent with overall Western US trends as industrial SO_2 sources have decreased. Many of the historic largest Western US SO_2 sources have shut down or are improving air pollution control technology.

Lichens



Lichens can be useful biologic indicators of air quality since many lichen species are very sensitive to air pollutants and accumulate air contaminants in lichen thallus tissue.
Dr. Larry St. Clair, BYU, has been collecting lichen samples in USFS Class 1 areas since 1992 including samples in the Anaconda-Pitler, Selway Bitterroot, Cabinet Mountains, and Bob Marshall Wilderness (St. Clair, 2005). These lichens samples area from wilderness areas that basically triangulate the RW and WCW . Several sites on the periphery of the Bob Marshall Wilderness were sampled in 2002 and 2003 for lichen amounts, lichen species and community composition, and elemental analysis of the lichen thallus tissue. For the Bob Marshall Wilderness sites St. Clair found (2005) 54 general and 139 species. Sixteen sites on the periphery of the Selway Bitterroot Wilderness (SBW) were established in 1992, 1993, and 1994 and re-sampled in 2000, 2001, and 2002 for lichen amounts, lichen species and community composition, and elemental analysis of the lichen thallus tissue. Elemental chemical analysis of 45 Selway Bitterroot Wilderness sites was done for all samples. For the Selway Bitterroot Wilderness sites, St. Clair found (2005) that some decreases and some increases in chemical concentrations between 1992 and 2000 to 2002. Four sites (all high elevation) showed moderately elevated sulfur concentrations in the 2001 samples. St. Clair speculates that the source could be long range transport. Some of the SBW sites had an increase in cobalt, arsenic levels, and elevated Fe/Ti ratios between sampling periods. The Cu/Zn rations were within background levels at all sites in 2000 to 2002. St. Clair concluded that the abundance of sensitive lichen indicator species and the high diversity of lichen species and well as substrate and growth form distribution patterns documents that the lichen in the Bob Marshall, Cabinets, and Selway Bitterroot Wilderness areas is healthy and relatively un-impacted by air pollution.

4) Wilderness Air Quality Values

Rattlesnake Wilderness

Visibility/Scenery

The Rattlesnake Wilderness (RW) and the adjacent Rattlesnake National Recreation Area and Wilderness (RNRAW) are just four miles north of Missoula and receive heavy human use. Elevations rises to 8,620 feet on McLeod Peak and a picturesque mountain setting. From Stuart Peak to the north a knife edge ridge climbs to the remote 8620-foot McLeod Peak. The east side of the ridge is marked by cliffs, cirques, and rolling basins of intermittent subalpine forest. The gentler western slopes lead down to the open bowl-like basin of upper Grant Creek. Visibility is an important WAQV since viewing of the scenic peaks of the RW and surrounding areas is an important wilderness attribute.

Lakes

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The Rattlesnake Wilderness contains about 52 high mountain lakes. All of these lakes are in Precambrian Missoula group (pCm) sedimentary/metamorphic and have moderate levels of alkalinity buffering to pH change. The lakes contain a rich and diverse aquatic ecosystem and fishery resource. Many of the lakes are periodically stocked. Predominant fish species include rainbow trout and Westslope Cutthroat trout.

Welcome Creek Wilderness

Visibility/Scenery

The Welcome Creek Wilderness rises gently from the main Sapphire Range Divide and then drops abruptly to form breaks that are steep and rough. Elevations range from 4,100 feet in the Rock Creek Basin to 7,723 feet on Welcome Peak. The WCC has about thirty miles of trails, most of which are on steep ridges and in the narrow stream bottoms. Although recreation use is light, visibility/scenic viewing is important to the visitors who hike or ride horseback to scenic vistas along the high points in the WCW.

5) Monitoring Plan

This RW and WCW WAQV plan is designed to specify appropriate monitoring to protect the Class 2 WAQV's in the Rattlesnake and Welcome Creek Wilderness areas and to meet the Wilderness Stewardship Challenge to achieve the objectives of the Air Element #3 http://www.wilderness.net/index.cfm?fuse=toolboxes&sec=air

The Wilderness Stewardship Challenge steps include selecting air quality values with an interdisciplinary team, rank air quality values, select receptors, and identify indicators to measure at the sensitive receptors. For the RW and WCW, the process included a review of existing air quality information in and adjacent to the RW and WCW with a determination that existing monitoring in the IMPROVE, NADP, USGS, and USFS Lichen networks is sufficient to characterize and monitor RW and WCW air quality for the key sensitive receptor (scenic vistas)

and sensitive indicator (visibility) except for some additional lake monitoring in the RW. This RW and WCW monitoring plan proposes not to do additional NADP, visibility, or particulate monitoring at this time since these air quality parameters are being adequately monitored in existing networks. Air quality monitoring in the RW and WCW will continue to be done with the existing USFS lake chemistry, IMPROVE, NADP, USGS snow chemistry networks and tracked and tabulated by USFS R1 Air Resource Management staff. This RW and WCW WAQV plan will need to be re-evaluated within a 5-10 year interval to insure monitoring sufficiency, particularly if upwind emission sources increase.

Visibility: The Rattlesnake Wilderness and Welcome Creek Wilderness WAQV monitoring plan is designed to provide additional information ~~monitoring~~ for the Class 2 WAQVs to supplement the existing Class 1 monitoring. Visibility in the RW and WCW is being reasonably characterized and monitored by the “umbrella” of the IMPROVE visibility monitoring sites at the MONT1 Monture Guard Station IMPROVE site (29 miles east of the RSW and 43 miles north of the WCW) and at SULA1 Sula Peak Lookout IMPROVE site (70 miles south of the RSW and 55 miles south of the WCW). Visibility at these 2 IMPROVE sites has documented good visibility with periodic reduction during periods of active wildfire, particularly in 2003. No large upwind industrial sources of air pollution occur between MONT1 and SULA1 and the RW and WCS wilderness boundaries. No additional visibility monitoring stations are recommended or planned for the RW or WCW.

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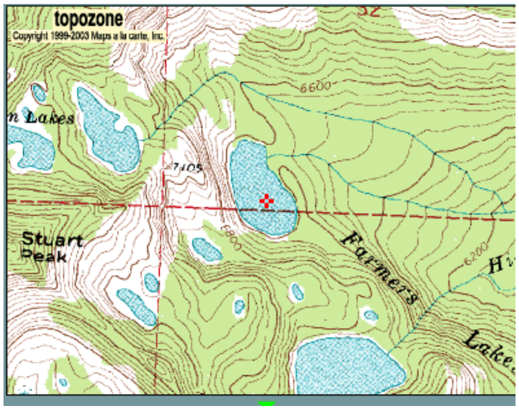
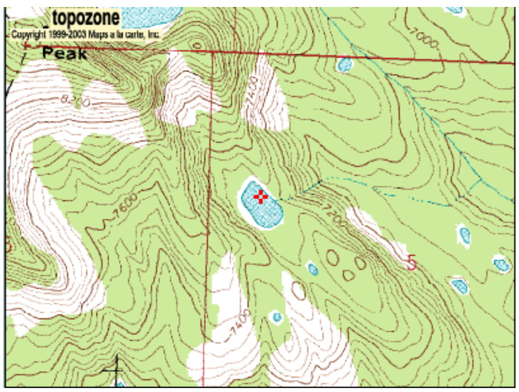
Lake Chemistry: The available RW lake information indicates moderately buffered lakes which are currently not sensitive to existing levels of atmospheric deposition. However, the RW lake chemistry database is limited and dated. This WAQV plan includes monitoring of the 2 EPA Western Lake Survey (1985) lakes an additional 6 lakes which the Montana FWP database indicates have the lowest alkalinity (similar to ANC). The lakes will be sampled in July 2007 to be consistent with the July sampling in all of the USFS Region 1 lake sampling. Subsequent lake monitoring, if any, will depend on the 2007 lake monitoring results.

The lakes to be sampled in 2007 include:

Lake	Location	Lake ID
Farmers 5	14N 18W S5 & 15N 18W S32	4C3-031
No Name	15N 18W S5	4C3-059
Big	15N 18W S19	DFWP
Carter	15N 18W S30	DFWP
Farmers1	14N 18W S3	DFWP
Farmers2	14N 18W S3	DFWP
Rattsnk20	15N 18W S14	DFWP
Twin	15N 18W S31	DFWP



Farmers Lake #5 to be sampled in July 2007. This is the same lake as the Western Lake Survey lake 4C3-031 which was sampled in 1985.



No Name lake to be sampled in July 2007. This is the same lake as the Western Lake Survey lake 4C3-059 which was sampled in 1985.

Mark Story will provide sampling, equipment, data sheets and protocols. Methods for the lake sampling include collection of primary and duplicate samples in the deepest part of each lake (raft access) in 250 ml sample bottles using sterile techniques. Surface Water Chemistry Monitoring Record Form and Chain of Custody forms will be completed and samples kept cool and immediately shipped to the USFS Fort Collins Science Center Lab. Laboratory analysis includes Fort Collins Science Center Lab Procedures**:** For pH & alkalinity--Acid Rain Analysis System (ARAS) gran technique; specific conductance--YSI meter; chloride, sulfate, nitrate, ammonia, phosphate, calcium, potassium, sodium, magnesium --liquid ion chromatography; fluoride--ion specific electrode; aluminum and silica--Lachat flow injection system. Selected magnesium and calcium chromatography values with atomic absorption (Thermo Jarrell Ash 22E). All analyses used QA/QC guidelines and EPA reference standards established in the Handbook of Methods for Acid Deposition Studies (EPA 600/4-87/026 and Standard Methods (APHA, 1989). The data will be reviewed for conformance with quality assurance standards prior to use. All of the lake data will be available on the USFS NRIS-Air database and on spreadsheets by USFS R1 Air Quality staff

Snow Chemistry

Snow chemistry will continue to be cooperatively monitored in late February and early March by the USGS Water Resource Division in Colorado. The 3 sites are near the RW and WCW include Snow Bowl (1 mile from RSW and 33 miles from WCW), Granite Pass (39 miles from RSW and 44 miles from WCW), and Red Mountain Pass (112 mile from RSW and 84 miles from WCW). The snow chemistry will be sampled primarily with USGS staff and NF personnel and financial support from the USFS R1 Air Quality Program budget. Chemical analysis (H^+, Ca^{2+}, Mg^{2+}, Na^+, K^+, HN_4^+, SO_4+, NO_3-, and Cl-) is analyzed in the USGS laboratory in Denver, Colorado ~~and~~ with data analysis and reporting completed by USGS Water Resource Division in Colorado. Snowpack chemistry data and reports are available at the USGS web site at http://co.water.usgs.gov/Pubs/index.html#OFR

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